

Appl. No. : **10/802,593**
Filed : **March 17, 2004**

REMARKS

This paper is in response to the Office Action dated March 18, 2005. Applicant has amended the application as set forth above. Specifically, Claims 1-3, 7, 8, 11-13, and 16-19 have been amended. New Claims 26-34 have been added, and Claims 20-25 have been canceled without prejudice. Upon the entry of the amendments, Claims 1-19 and 26-34 are pending in this application. No new matter is added by the amendments as discussed below. Applicant respectfully requests the entry of the amendments and reconsideration of the application in view of the above amendments and the following remarks.

Discussion of Amendments

The title of the invention has been amended to accommodate the Examiner's request. The new title is fully supported by the disclosure of the application as originally filed.

The amendment to the specification is to correct a grammatical error.

Claim 1 has been amended to clarify the invention. Support for the amendments to Claim 1 can be found in the originally filed specification and the drawings, including, e.g., paragraphs [0031], [0037], and [0068] of the specification and Figures 3-6f.

Claims 2 and 8 have been amended to correct grammatical errors.

Claim 5 has been amended to delete part of the limitations.

Claim 7 has been amended to incorporate the limitations of its base claim, Claim 1.

Claim 11 has been amended to make it depending from and consistent with Claim 1. The limitations added in Claim 11 are supported by the original specification and drawings, more specifically by the descriptions and illustrations which support the amendments to Claim 1.

Claims 12, 13, and 16-19 have been amended to correct grammatical errors and to make them consistent with the changed language in Claim 11.

New Claim 26 is supported by the original specification and figures, for example, paragraphs [0037], [0042], [0048], [0054], [0068], [0079], and [0088].

New Claims 27-30 are supported by the original specification, including, e.g., original Claims 2, 3, 4, and 9.

New Claims 31-34 are supported by the specification, including original Claims 11 and 20.

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Applicant respectfully submits that the foregoing amendments are fully supported by the application as originally filed and do not constitute the addition of new matter. Applicant respectfully requests the entry of the amendments.

Request for Rejoinder of Claims 11-19

M.P.E.P. 821.04 sets forth that in the case where product claims are presented for examination, when the product claims are found allowable, process claims directed to making and/or using the product which depend from the patentable product claims will be entered as a matter of right. Applicant respectfully notes that currently withdrawn Claims 11-19 and 31-34 are drawn to a method of fabricating a photodiode and depend directly or indirectly from Claim 1, which is allowable as discussed below. Therefore, Applicant respectfully requests that Claims 11-19 and 31-34 be rejoined upon the allowance of Claim 1.

Information Disclosure Statement

The Examiner noted that the references listed in the specification have not been considered by the Examiner and suggested that Applicant file a proper form of Information Disclosure Statement. In reply, Applicant is filing an Information Disclosure Statement (IDS) listing references referred to in the specification along with this paper.

Discussion of Objection to Title of the Invention

The Examiner noted that the title of the invention is not descriptive. Applicant respectfully disagrees with the Examiner and submits that the original title of the invention is descriptive. However, solely to expedite the prosecution, Applicant has amended the title of the invention as set forth above. Applicant submits that the new title of the invention is more descriptive than the original title.

Discussion of Objection to Claim 8

The Examiner objected to Claim 8 as the term "the InAlAs semiconductor layer" lacks sufficient antecedent basis. Applicant has amended Claim 8 as suggested by the Examiner.

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Discussion of Rejection Under 35 U.S.C. § 102

The Examiner rejected Claims 1-5, 8, and 10 under 35 U.S.C. § 102 (b) as being anticipated by Tanaka et al. (2002/0117697). Applicant respectfully disagrees with the Examiner and submits that Tanaka does not anticipate the rejected claims as discussed below.

The Law of Anticipation

Anticipation under Section 102 can be found only if a reference shows exactly what is claimed. *Titanium Metals Corp. v. Banner*, 778 F.2d 775 (Fed. Cir. 1985). More particularly, a finding of anticipation requires the disclosure in a single piece of prior art of each and every limitation of a claimed invention. *Electro Med. Sys. S.A. v. Cooper Life Sciences*, 34 F.3d 1048, 1052 (Fed. Cir. 1994). "To anticipate, every element and limitation of the claimed invention must be found in a single prior art reference, arranged as in the claim." *Brown v. 3M*, 265 F.3d 1349 (Fed. Cir. 2001). "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385 (CCPA 1970).

Disclosure of Tanaka

Tanaka discloses seven different constructions of mesa-structured semiconductor photodiodes. Among these embodiments of Tanaka, the Examiner stated that only embodiments 2 (Figure 7 and paragraphs 60-75) and 5 (Figure 16 and paragraphs 99-103) are relevant to the current claim set.

The embodiment 2 of Tanaka includes an InP substrate (n-type) 21; an InAlAs buffer layer (n-type) 22; an InAlAs/InGaAs multiplication layer (n-type) 23; an InAlAs field control layer (p-type) 24; an InGaAs field control layer (p-type) 25; an InAlAs field control layer (p-type) 26; an InGaAs absorption layer (p-type) 27; an InGaAlAs cap layer (p-type) 28; an InGaAs contact layer (p-type) 29; electrodes 31, 32 and a protection film 33. See Tanaka at paragraph [0062] and Figure 7. The photo-diode includes three stacked field control layers; i.e., the InAlAs field control layer 26 is formed on the InGaAs field control layer 25, which is formed on the InAlAs field control layer 24. The lateral (horizontal) span of the InAlAs field control layer 26 is significantly smaller than that of the InGaAs field control layer 25 as shown in Figure 5.

Similarly, the embodiment 5 of Tanaka discloses a photodiode including three stacked field control layers, i.e., an InP field control layer (n-type) 256 is formed on an InGaAs field control layer (n-type) 255, which is formed on an InP field control layer (n-type) 254. See

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Tanaka at paragraph [0101] and Figure 16. Again, in this construction, the horizontal span of the InGaAs field control layer 255 and InP field control layer 256 is significantly smaller than that of InP field control layer 254.

Tanaka does not disclose or teach variation of charge density within each of the field control layers 24-26 and 254-256. Further, Tanaka does not disclose or teach use of beryllium (Be) or magnesium (Mg) ions in the field control layers.

Tanaka Does Not Anticipate Claims 1-5, 8, and 10

Claim 1 is directed to a photodiode comprising a (second conduction type) field controlling layer formed over an amplifying layer. Claim 1 as amended recited that the field controlling layer comprises a central portion and a peripheral portion, which is positioned on a side of the central portion in a horizontal direction thereof, and that the central portion has a charge density higher than that of the peripheral portion.

Tanaka fails to disclose the features of Claim 1. As discussed above, Tanaka does not disclose or teach variation of charge density in the field control layers at all. As such, Tanaka cannot provide the claimed features that the central portion has a charge density higher than that of the peripheral portion which is positioned on a side of the central portion in a horizontal direction thereof.

Applicant notes that Tanaka discloses that one of its field control layers has a longer horizontal span than another. Regardless of the charge densities of these field control layers, however, this configuration does not teach the claimed features because that each field control layer is formed over another (i.e., stacked in a vertical direction) and therefore any portion of one field control layer cannot be positioned on a side of another in a horizontal direction.

In view of the foregoing, Tanaka does not disclose every element of Applicant's Claim 1 and therefore cannot be an anticipatory reference under 35 U.S.C. § 102(b). Claims 2-5, 8, and 10 depend from Claim 1 and therefore incorporate all the limitations of Claim 1. In view of no anticipation of Claim 1, Tanaka does not anticipate any of Claims 2-5, 8 and 10. Applicant respectfully request that the rejection of Claims 1-5, 8, and 10 be withdrawn.

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Discussion of Rejection Under 35 U.S.C. § 103

The Examiner rejected Claims 6 and 9 under 35 U.S.C. § 103 (a) as being unpatentable over Tanaka in view of Clark (U.S. Patent No. 6,794,631). Applicant respectfully disagrees with the Examiner and submits that the rejected claims are patentable over the references alone or in combination, as discussed below in detail.

Standard for Obviousness Rejection

The Patent and Trademark Office has the burden under section 103 to establish a *prima facie* case of obviousness. *In re Piasecki*, 745 F.2d 1468, 1471-72, 223 USPQ 785, 787-87 (Fed. Cir. 1984). To establish a *prima facie* case of obviousness, three basic criteria must be met: first, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; second, there must be a reasonable expectation of success; and finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. *See* M.P.E.P. § 2143. All words in a claim must be considered in judging the patentability of that claim against the prior art. *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988).

Clarification About Clark

The Office Action stated at page 7, line 13 that the Clark reference is U.S. Patent No. 4,326,211, which is issued to Smeets, et al., not Clark. According to Applicant's investigation, Clark is U.S. Patent No. 6,794,631, which is cited in the Examiner's Notice of References Cited. The Examiner's discussion of the Clark reference is consistent with U.S. Patent No. 6,794,631, not U.S. Patent No. 4,326,211. Thus, Applicant considers U.S. Patent No. 6,794,631 issued to Clark in the following discussion. If this approach is incorrect, Applicant respectfully requests that the Examiner provide reasons therefor in the next Office Action.

Disclosure of Clark

Clark discloses avalanche photodiodes having a third terminal. The third terminal is a peripheral ring terminal, which collects charge carriers generated outside the optically-active region of the device. The Examiner cited Clark only to provide Tanaka's deficiencies relating to the features recited in Claims 6 and 9, not to remedy the feature of Claim 1.

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Nonetheless, Clark's photodiodes include an undoped multiplication layer 104 and a doped thin dose layer 105 over the undoped multiplication layer 104. The undoped multiplication layer 104 and the doped thin dose layer 105 are together called a multiplication region 103. See Clark at column 4, lines 33-53. The photodiodes of Clark have a grading layer(s) 106 above the multiplication region 103, and an absorption layer 107 above the grading layer(s) 106. *Id.* at column 4, lines 54-55 and 66-67. As such, in Clark, the dose layer 105 and grading layer(s) 106 are located between the multiplication layer 104 and absorption layer 107. The photodiodes further includes a contact layer 112, which includes a central region 112a and a peripheral region 112b. *Id.* At column 5, lines 45-51.

Clark states that the thin dose layer 105 is p-doped to a very specific areal dose (e.g., approx. $2 \times 10^{16} \text{ cm}^{-3}$). *Id.* at column 4, lines 37-39. The doping characteristics of the dose layer 105 are defined through an epitaxial growth process. *Id.* at column 7, lines 15-17. Accurate control of the impurity concentration within both of the layers 104 and 105 constituting the multiplication region 103 is important. *Id.* at column 7, lines 22-25. However, Clark does not disclose or teach further details of the doping.

Further, Clark's claims, Claims 1 and 11, recites that the multiplication layer 104 has an undoped region of a second semiconductor material and the dose layer 105 has a doped region of a third semiconductor material. However, Clark discloses neither where the undoped region exists in the multiplication layer 104 nor whether the doped region exists in the dose layer 105.

No *Prima Facie* Case Has Been Established

Applicant would like to discuss the patentability of Claim 1 as Claims 6 and 9 depend from Claim 1. As discussed above in connection with the 102 rejection, Tanaka failed to disclose or teach, among other things, the claimed features that the central portion has a charge density higher than that of the peripheral portion which is positioned on a side of the central portion in a horizontal direction thereof. Clark does not remedy this deficiency of Tanaka.

As discussed, Clark discloses a photodiode including the dose layer 105 and grading layer 106, which are located between the multiplication layer 104 and absorption layer 107. In comparing this construction with the photodiode of Claim 1, either or both of the dose layer 105 and grading layer 106 of Clark might correspond to the second conduction type field controlling layer in view of its position relative to other layers of the claimed photodiode. As noted above,

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however, neither the dose layer 105 nor the grading layer 106 of Clark has the claimed feature that the central portion of the second conduction type field controlling layer has a charge density higher than that of the peripheral portion which is positioned on a side of the central portion in a horizontal direction thereof. Clark fails to teach any variation of charge density in the dose layer 105 and grading layer 106. Also, Clark's use of the term "doped region" in its claims fails to provide the location of the doped region in the dose layer 105. Further, the terms, central portion and peripheral portions, used in Clark refer to portions of a contact layer 112, which is irrelevant to the dose layer 105 or grading layer 106.

As such, Clark fails to teach or disclose the claimed features that Tanaka fails to teach or disclose. Thus, Tanaka and Clark in combination do not teach every element of Claim 1. Therefore, no *prima facie* case of obviousness has been established, and Claim 1 is patentable over Tanaka and Clark either alone or in combination. Accordingly, Claims 6 and 9, depending from Claim 1, are also patentable over these references. Applicant respectfully requests the withdrawal of the rejection.

Allowable Subject Matter

Applicant gratefully acknowledges that Claim 7 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicant has amended Claim 7 as set forth above to incorporate the limitations of Claim 1, from which Claim 7 depended before the amendment. Applicant respectfully submits that Claim 7 as amended is allowable.

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CONCLUSION

In view of Applicant's amendments to the claims and the foregoing remarks, Applicant respectfully submits that the present application is in condition for allowance. Should the Examiner have any remaining concerns, which might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number appearing below.

Respectfully submitted,

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